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ABSTRACT

A review of the literature on systematic instructional design suggests that few empirically tested guidelines exist for testing and revising materials during the development stages. The revision process can broadly be based on one of two distinct strategies, internal review or developmental testing. Internal review strategies include referring once again to each of the components in the original design sequence and using additional guidelines or checklists beyond the ones provided in the original design model. Developmental testing involves testing materials and improving them on the basis of feedback from potential learners. Developmental testing-based revision strategies include: (1) indicating errors by noting nonverbal behavior of test subjects, using "frame errors," and reviewing posttest data; (2) determining the importance of errors, using criterion performance on a posttest; (3) localizing errors by asking students and by keying posttest items directly to instructional content; (4) determining causes of errors such as learner attributes, prerequisite problems, and/or defective teaching; (5) making changes by checking against original design algorithms; and (6) testing out the revision via student data, experts' opinions, and job performance analysis. Appendices include a bibliography and a summary table of the preceding developmental testing-based revision strategies. (LH)

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Instructional development: revision procedures

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Well imbedded in the literature of systematic instructional design are the procedures commonly referred to as developmental testing and revision. These procedures are prescribed in almost all existing models of the instructional development process.

The revision process can broadly be based on one of two very distinct strategies---internal review or developmental testing.

Internal review consists of the examination of the design or content by the content expert and the instructional designer. In practice,using an instructional design "algorithm" to produce instructional materials may not guarantee a successful product. Therefore, a review is usually recommended. That review may simply involve referring once again to each of the components in the original design sequence this time with the draft version in hand. "Revision, after all, is merely the application of development techniques at a different point in time."(Gropper,1975 , p.187.) This strategy assumes that the errors that learners would make while going through instruction are caused by faulty design procedures ---by not adhering closely enough to the original design model.

This seems to put revision into a somewhat paradoxical position. If

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the model of systematic instruction is in fact valid, then why would an instructional design team need to go back into the design via internal review? Superficially, the procedure seems redundant; however, the reliability (e.g.,effectiveness) and validity (e.g., accuracy) of the first draft may need to be checked because deviation from the original instructional design model may have occurred as the materials were produced, or the model,being a general one, simply does not provide precise enough guidelines for specific decisions.

Another internal review strategy involves the use of additional guidelines or checklists beyond the ones provided in the original design model. Authors providing reiterative internal review guidelines, e.g., Merrill, Reigeluth, and Faust (1979); Markle (1978); and Montague, Ellis, and Wulfeck (1983), have eliminated or at least reduced the emphasis on expensive and time consuming developmental testing.

Lawson (1974) distinguishes between internal and external information. The former, "information which can be generated by inspecting the product itself," is derived from the kind of internal review being discussed here. External information would include that which is obtained from developmental testing.

He offers numerous checklists which provide cues for the internal review process. Many of these resemble the checklists devised by evaluators for the summative evaluation of instructional materials (see, for example, Eiss, 1970.) There is no particular reason to exclude these summative checklists from consideration if one is seeking job aids to assist in internal review during formative evaluation.

It is surprising that few comparisons have been made which address the important question: how does the effectiveness of revision based on

internal review compare with that based on developmental testing data? Golas ,(1983) in a recent study, found no significant differences. Of course, one suspects that the answer will depend on a variety of variables such as the kind of teaching materials being tested, the internal review procedures that have been used and particular features of the developmental testing procedure. The question is a serious practical one with major implications for cost-effectiveness; clearly more comparisons should be done.

As noted at the outset,a large number of authors do find some need for the testing out of proto-type instructional materials with potential learners. From this perspective, revision is a diagnostic and prescriptive process, based on developmental testing, in order to produce instructional materials that meet set performance criteria. In this strategy, developmental testing and revision are two procedures which function inter-dependently. How an instructional designer developmentally tests will markedly influence the kinds of information obtained, the amount of information obtained, and the whole revision process.

Within the context of developmental testing-based revision as a global strategy, a number of sub-strategies exist. These strategies emerged as our research team culled revision algorithms, heuristics, rules, and guidelines from the literature (see,Geis,et al,1984.) Figure 1 broadly charts these revision strategies.

The first box identifies the process of indicating errors. Every author utilizes some method of "flagging" errors, e.g., by test subject's non-verbal behavior, "frame errors", or from post-test data.

The next step is to determine the importance of the error. Typically, criterion performance on the posttest is used in making this decision. Error

tolerance (i.e., the threshold for importance of the error) varies among authors. Thresholds of 20% or more of the test subject group scoring incorrectly on 20% or more of the items on the post-test with not more than 20% unfavorable responses on an attitudinal survey, are suggested by Abedor (1971); Friesen (1973) suggests that if 7% or more of the test subjects are having trouble on a frame revisions are called for;30% or more of the tryout learners incorrectly responding 30% of the time or more, should alert the designer, say Johnson and Johnson (1975); revise until consistent results are obtained, Thiagarajan, et al (1974), and Baker and Schutz (1971); revision should be considered if 20% to 30% or more of the test group answered a particular test item incorrectly and if 30% or more deviate two or more marks from the "ideal" on a Likert-type reactionnaire, Bell and Abedor (1977).

Next,the error must be geographically located. Some authors, Abedor (1971); Dick and Carey (1978); Friesen (1973); Johnson and Johnson (1975); Bell and Abedor (1977); Deterline and Lenn (1972); and Horn (1966), ask the test subject(s) to locate the problems which they encounter when using the materials. Other authors, Markle (1978); Bjerstedt (1972); Deterline and Lenn (1972); Baker and Schutz (1971); and Dick and Carey (1978), have keyed the post-test items directly to the content in order to pinpoint the problem. Two of the authors above combined both keyed test items and student localized problems as their methodology. Test subjects can isolate errors by a number of suggested routes: they can verbally indicate problems to the developer, write the problems down on a revision comment sheet, or write on the instructional materials themselves.

After localization,the developer-reviser must determine the cause of problems or errors. The cause of instructional failure can be simply a

matter of insufficient prerequisites, as determined through developmental testing. One of the major purposes of developmental testing is seen,by Markle (1978), as providing the environment for the emergence of both prerequisites and learner attributes. Such errors might indicate a need for more branching in the instruction or could suggest another location for the learner within the curriculum. Necessary general learner attributes such as I.Q. and reading ability also become more apparent through developmental testing. Obviously, the product may be simply defective in teaching, Horn (1966); Dick and Carey (1978); Friesen (1973); Brethower (1965); Wydra (1980); Johnson and Johnson (1975); Thiagarajan, Semmel, and Semmel (1974); and Bjerstedt (1972). When the defect has been identified, during developmental testing, the instructional developer may override the instruction and teach/tutor the student. Defective original instruction can then be supplemented with effective designer instruction. It is often recommended that whole session be recorded, in which case revision simply becomes a matter of transcribing the "teaching" into the materials. The causality of error is implied by the successful remediation provided.

Going well beyond a recommendation to recycle through the original design procedure if errors are evident, a few authors have developed revision algorithms for use in indicating problem/error causation: Merrill and Tennyson 1977; Deterline and Lenn 1972; Gropper 1975; Dick 1968; and Robinson 1972. In addition, this group of authors provides specific prescriptions for changes to make after causation has been determined.

Often in developmental testing-based revision, the actual changes that are made are done on-the-spot during the testing session (a procedure typically proposed by those advocating clinical,one-to-one sessions.) Revisions can also be made after developmental testing (i.e.,after the posttest,) a

procedure advocated by those who use larger test groups and include a debriefing session after instruction.

Revision, much like developmental testing, spans a continuum of roles for the test subjects participating in a testing session. On one end of the spectrum, learners function solely in the traditional mode of attending to the material, working through it, and finally indicate their learning when pre and post-test results are compared. At the other end of the spectrum the subject assumes the role of "colleague" with the designer. As such, the test subject is viewed as someone who can give valid and useful comments about features of the instruction which fail to provide the suitable conditions for criterion performance. The test subject may be asked actually to revise the instructional material.

There is a large body of relevant research on using students to teach students, e.g., Allen (1976); Gartner, Kohler, and Riessman (1971); and Lippitt, Eiseman, and Lippitt (1969). Peer tutoring has been demonstrated to be an effective method of managing the teaching and learning environment. There is empirical support that students can be just as effective, given training, as professionally qualified teachers, Jenkins, Mayhall, and Reschka (1974). Perhaps if students can teach students, those "tutors" can also inform instructional designers about the optimal conditions for their learning. There is little comment in the literature about the intriguing matter of preparing students to become good critics in developmental testing sessions.

At the outset of this paper we contrasted the two approaches to revision: internal review and student testing.In fact this issue is not one of choosing between the two. Rather, the purposes and roles of each procedure need to be defined clearly. Surely some user data provide valuable

information. But questions of accuracy and relevance (to, say, an academic discipline) must be addressed also if instruction is to be pronounced valid (see, Geis,1973.) As Markle (1983) notes:

"Expert appraisal and valuing are equally as important as student data. Content quality,both input and potential output, is a different issue from learnability. No amount of data from students can validate the quality of potential outcomes or curricula excellence."(p.29)

Content experts' opinions,job performance analysis and other sources beyond student data should be considered seriously while recognizing the specific attributes of the curriculum to which these inputs may contribute. Most "checklists" for evaluating instruction through internal review mix some aspects of validity (e.g., accuracy) with judgements on learning effectiveness.

The major source of information for pedagogical analysis (and for revision directed to pedagogical matters) would seem to be the learner. Rules for teaching and for instructional design exist and presumably are consulted before instruction and afterwards consulted again to guide revision. But the proof of instructional effectiveness must be the exhibition of new learning by the student. As long as the "algorithms" directing the instructional design process are incomplete,inaccurate and ambiguous, and as long as the users of those algorithms may err in applying them, there is no substitute for trying out the prototypic instruction.

Few of those who hold high the banners of student testing have voiced the important concern examined in detail by Gropper (1975.) He forcefully reminds us of the criticality of the well-designed posttest as the cornerstone of the student data base. He suggests that although there is a place for the observation of student learners in one-to-one testing sessions, the developer may overly emphasize or react to data obtained in these sessions. In doing

so he or she may "shore up" faulty instructional materials, eliminating the moment-by-moment difficulties the students encounter. As a result, the instruction may procede more smoothly with the next learner, but repairs such as these may actually further bury deep faults in the learning materials. Thus changing a word or redrawing an illustration may eliminate further student error and comment, but such repairs are directed toward superficial aspects of the instruction. Afterwards on a comprehensive posttest these, now "satisfied," students may fail to exhibit acceptable performance. The developer has failed to recognize and deal with deep problems in the materials (e.g., poor sequencing, ambiguous definitions.) The proof of the instructional pudding must be the post-instructional student performance. Consequently the posttest itself must be technically well-designed and comprehensively sample all of the instructional objectives.

Gropper's discussion recalls the studies of programmed instruction which focussed on "frame error rate." Repeatedly evidence was presented that low error programs did not necessarily "teach"; some programs with sizeable error rates nevertheless proved to be effective instruction. Ease of progress through the instructional materials does not insure learning. Gropper urges us not to lose sight of the goal of an excellent final student performance while we are engaged in the preceeding process of developmental testing.

A later phase of our own research will involve detailed examination and comparison of various revision algorithms, suggestion by suggestion, rule by rule. Future experimental research will assay the effects of different developmental testing procedures on the production of data for revision. We should be able to determine how the varying student and developer roles in both one-to-one and group testing situations, along with the other key variables, determine, both quantitatively and qualitatively, the production of

data for revision. These analyses will reveal the types of revisions that can be expected from student test subjects in comparison with developer-generated revisions. Ultimately, we intend to compare the revisions of both student and developer by experimentally testing out the two "versions" of revised instructional material. This should be useful in evaluating the effects of the various revision strategies. This is a step towards giving empirical support, previously lacking, to the various rules and guidelines currently being endorsed in systematic instructional design.

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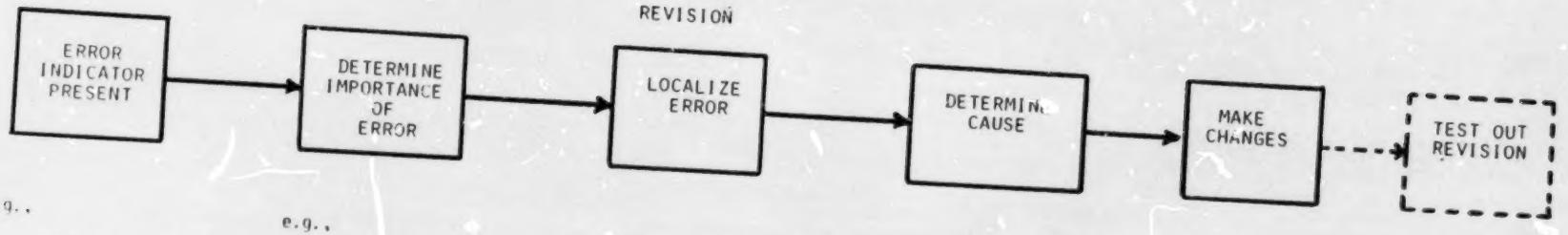
FIGURE 1

REVISION



e.g.,

- "frame errors"
- student non-verbal behavior
- post-test data

e.g.,

- criteria for revision (30 failure on post-test)

e.g.,

- ask student
- key post-test item to instructional content

e.g.,

- learner attributes?
- prerequisite problems?
- defective teaching?
- algorithms?

e.g.,

- algorithms for change
- check against original design algorithm (internal review)

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